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(54) **IMAGE FORMING APPARATUS**

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(51) **Int. Cl.**

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G03G 15/00	(2006.01)
B65H 5/06	(2006.01)
B65H 9/00	(2006.01)
G03G 15/01	(2006.01)

(52) **U.S. Cl.**

CPC ***G03G 15/6561*** (2013.01); ***B65H 5/021*** (2013.01); ***B65H 5/062*** (2013.01); ***B65H 9/006*** (2013.01); *B65H 2404/253* (2013.01); *G03G 15/0194* (2013.01)

(58) **Field of Classification Search**

CPC G03G 2215/00139; G03G 15/6558; G03G 15/6567; G03G 2215/0141; G03G 15/6561; B65H 2404/253; B65H 5/021; B65H 9/006

See application file for complete search history.

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(57) **ABSTRACT**

An image forming apparatus, including a conveyer unit, an image forming unit, and a registration unit, is provided. The conveyer includes a first roller, a second roller, and a belt having a first surface to contact the sheet. The image forming unit forms an image on the sheet in an image forming area. The registration unit is on an upstream side of the image forming area and includes a third roller and a fourth roller. A rotation axis of the third roller is on a side of the first surface, and a rotation axis of the fourth roller is on a side of a second surface of the belt, which is a reverse surface of the first surface. The registration unit manipulates the third and fourth rollers to align the sheet with a reference orientation and convey the sheet to the belt.

13 Claims, 9 Drawing Sheets

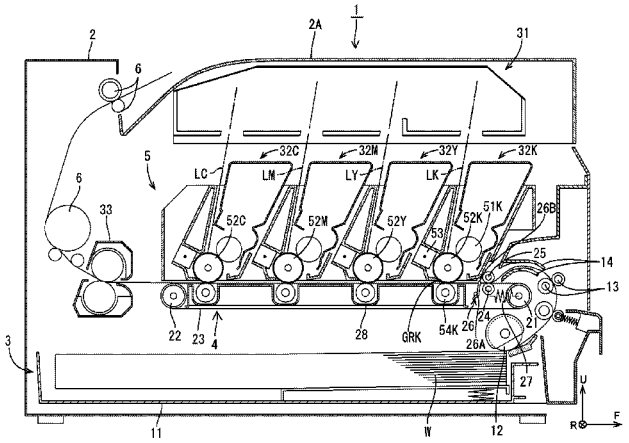
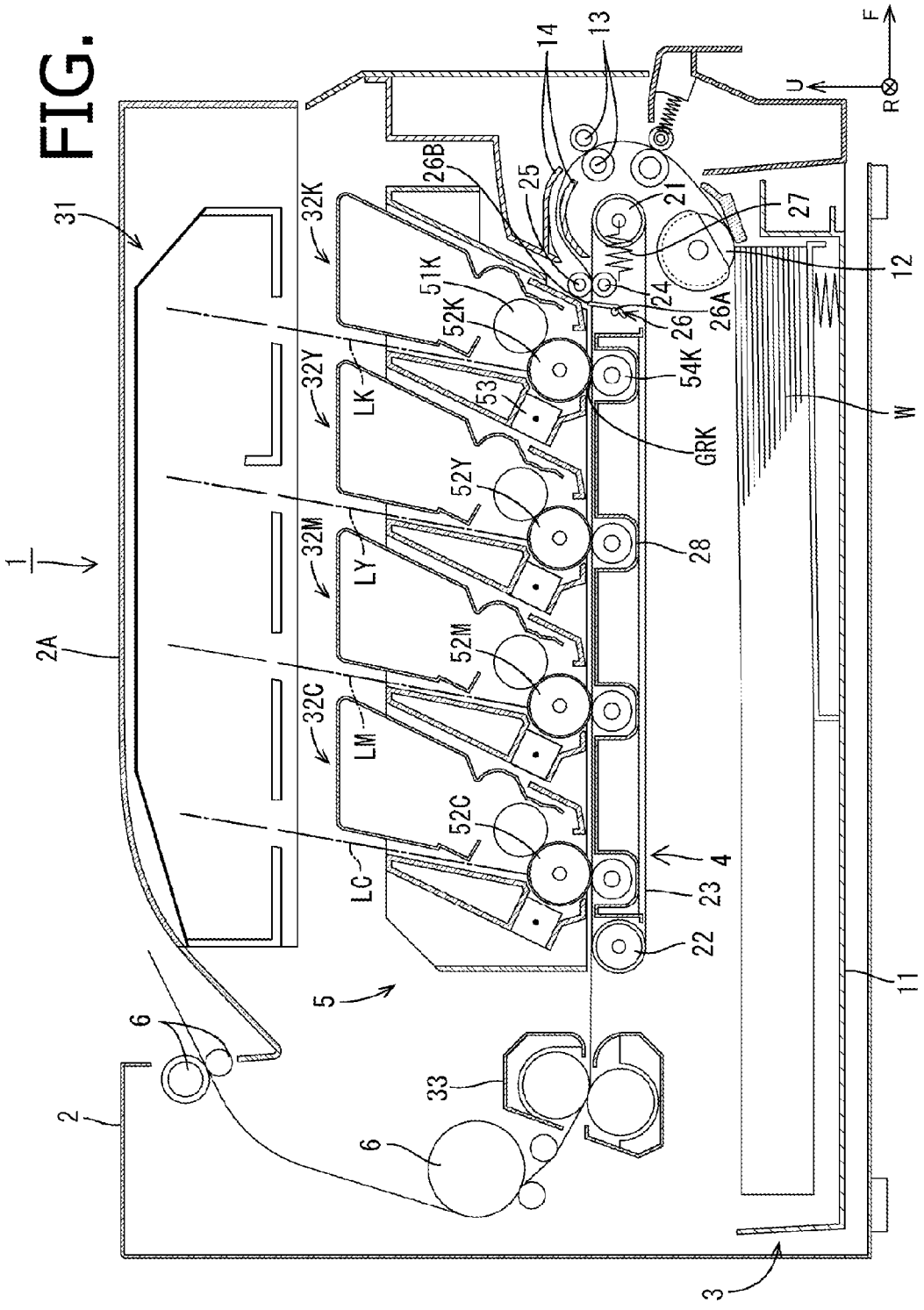


FIG. 1


1
2
2A
3
4
5
6
11
12
13
14
21
22
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28
31
32K
32Y
32M
32C
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LK
LY
LM
LC
GRK
W
F
U
R

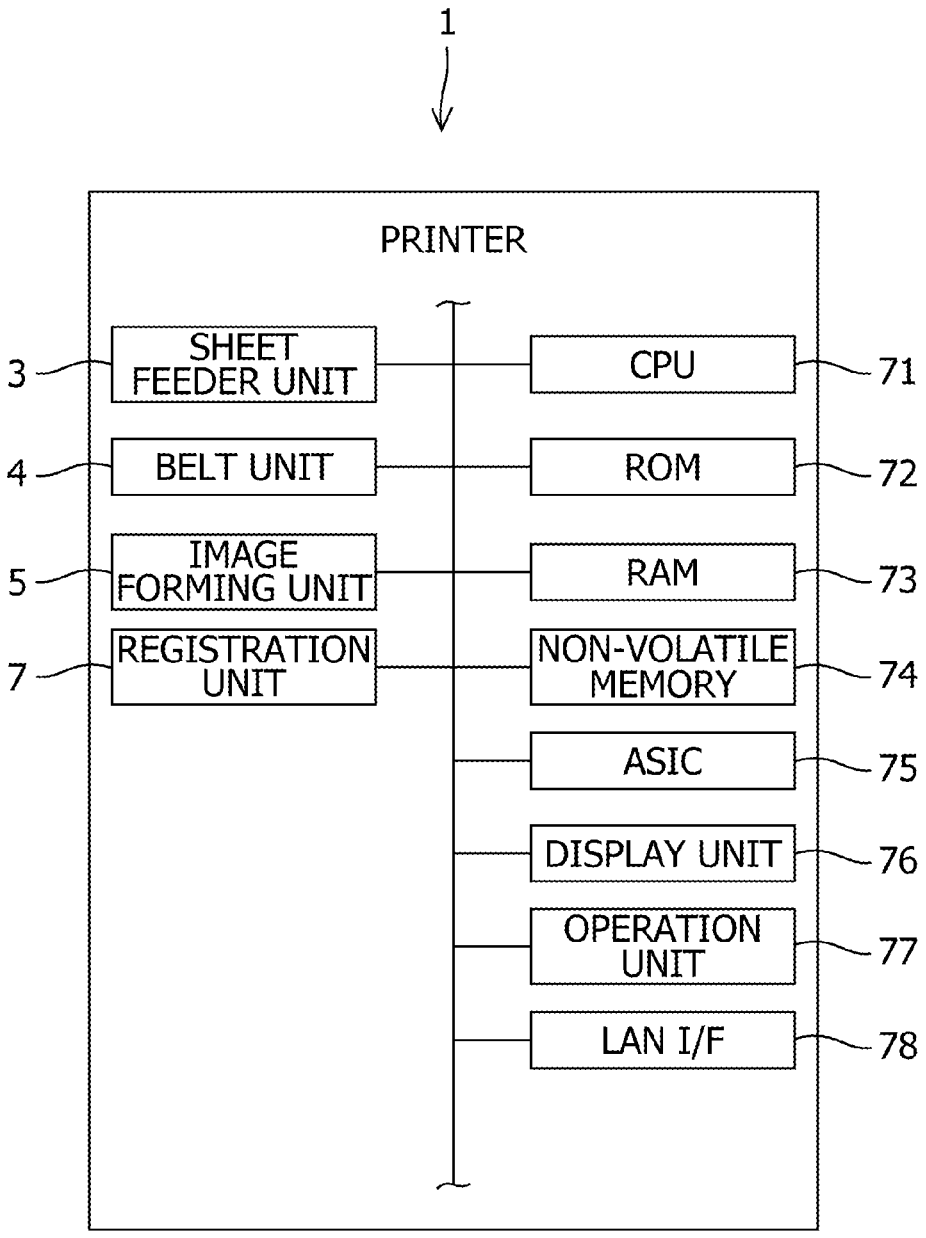

1
PRINTER
SHEET FEEDER UNIT
3
BELT UNIT
4
IMAGE FORMING UNIT
5
REGISTRATION UNIT
7
CPU
71
ROM
72
RAM
73
NON-VOLATILE MEMORY
74
ASIC
75
DISPLAY UNIT
76
OPERATION UNIT
77
LAN I/F
78

FIG. 2

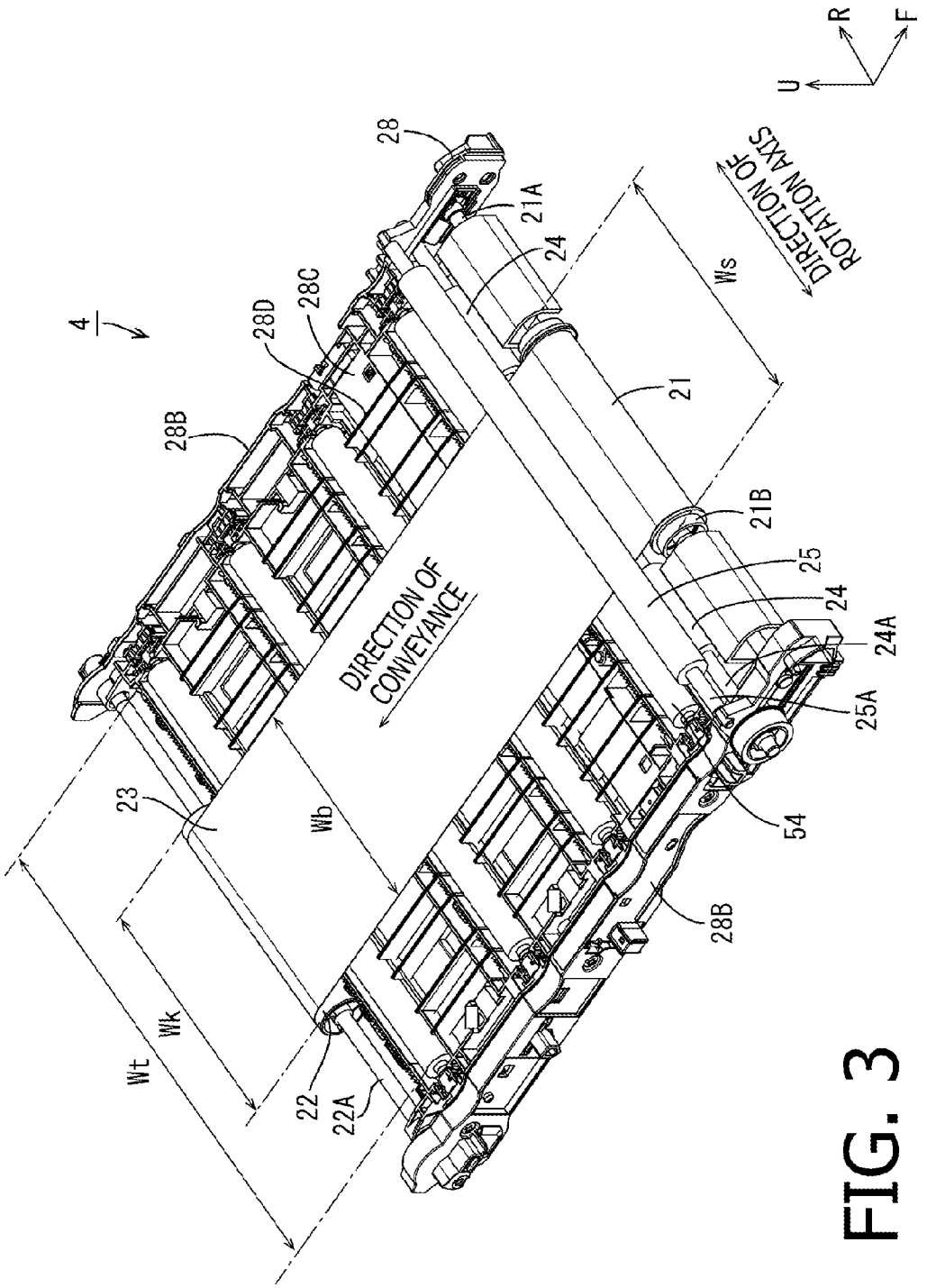
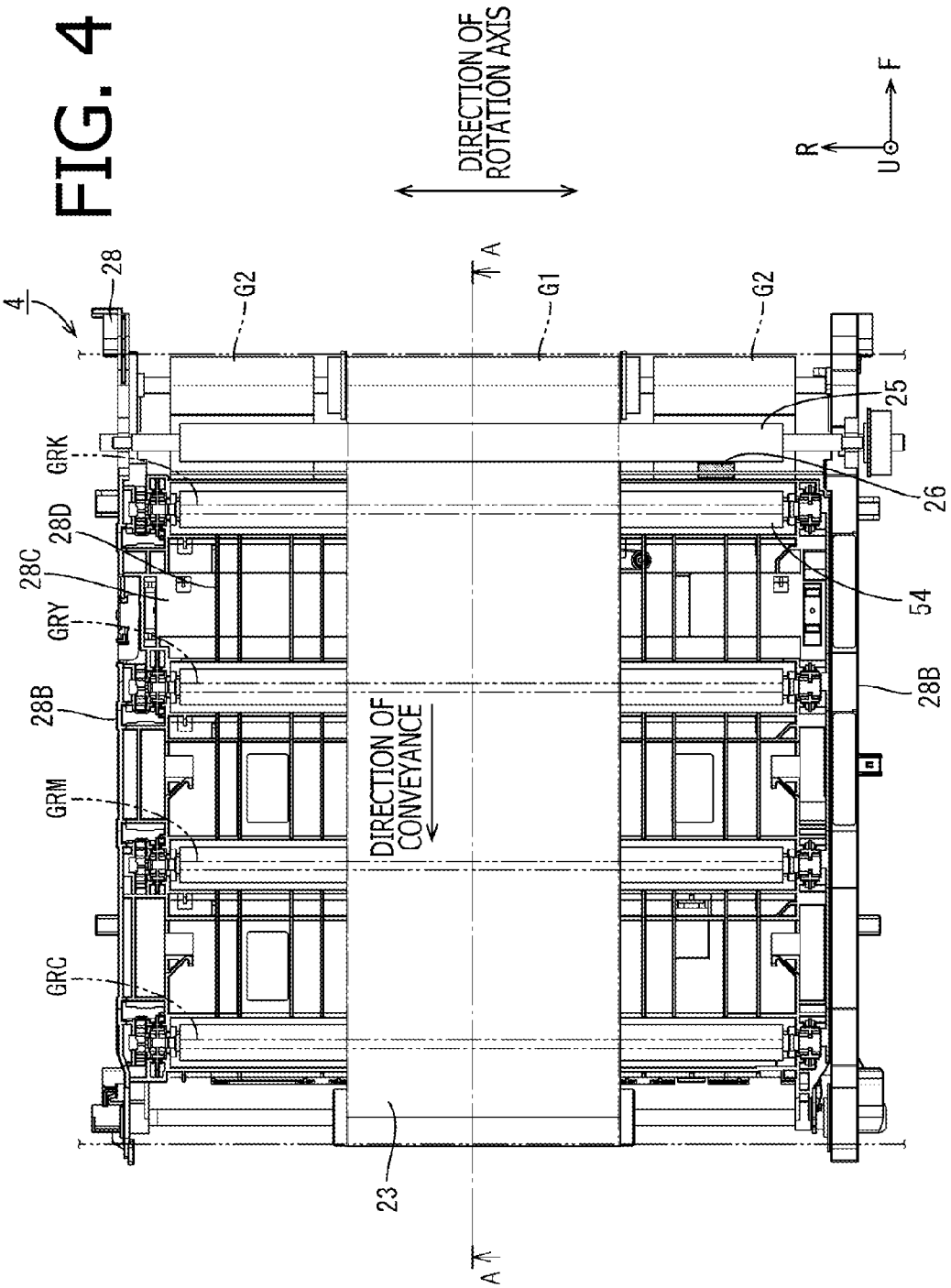

U
R
F
4
28
21A
24
Ws
DIRECTION OF ROTATION OF AXIS
28C
28D
28B
21
21B
25
24
24A
25A
DIRECTION OF CONVEYANCE
23
Wb
54
28B
Wt
Wk
22
22A

FIG. 3

FIG. 4


DIRECTION OF ROTATION AXIS
R
F
U
4
28
G2
A
G1
G2
25
GRK
26
28D
28C
54
GRY
28B
28B
DIRECTION OF CONVEYANCE
GRM
GRC
23
A

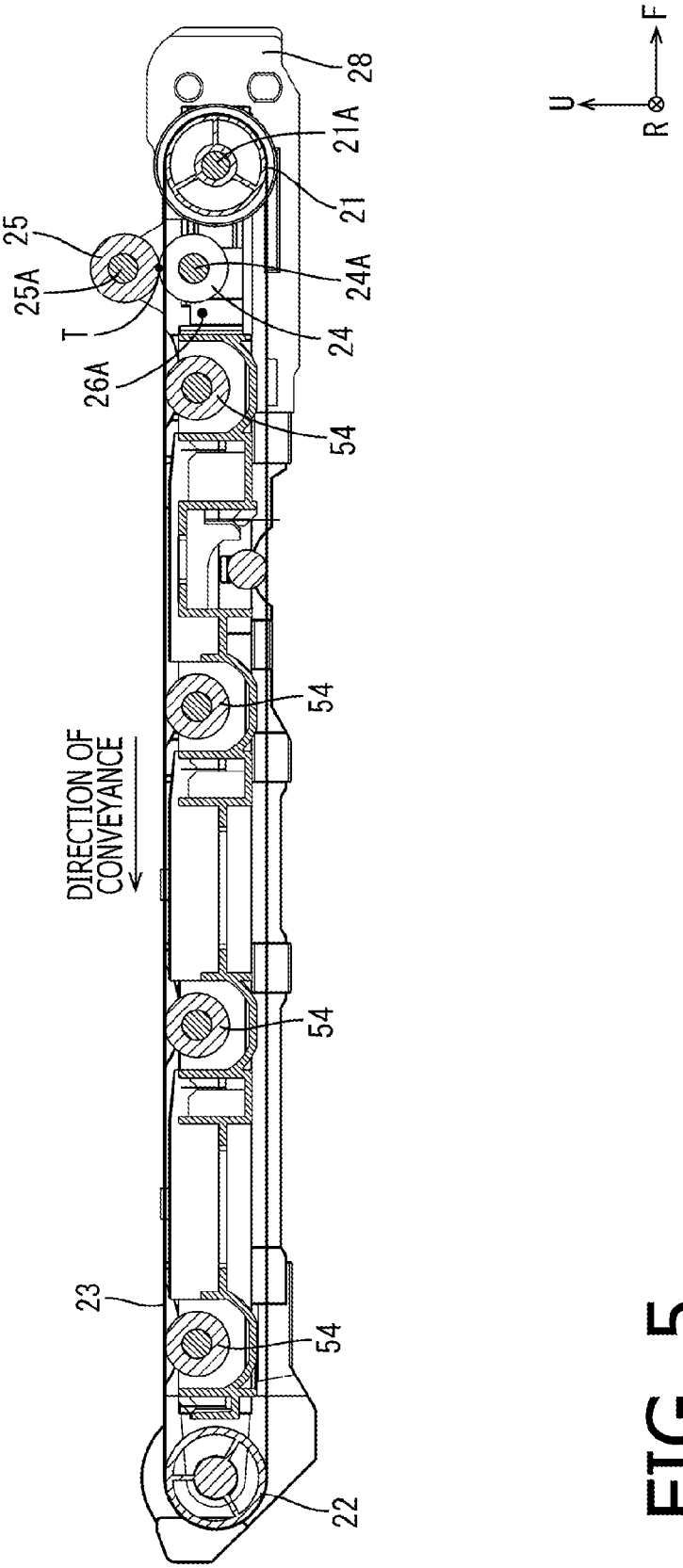

28
21A
21
25
25A
24A
T
24
26A
54
54
DIRECTION OF CONVEYANCE
54
54
23
54
22
U
F
R

FIG. 5

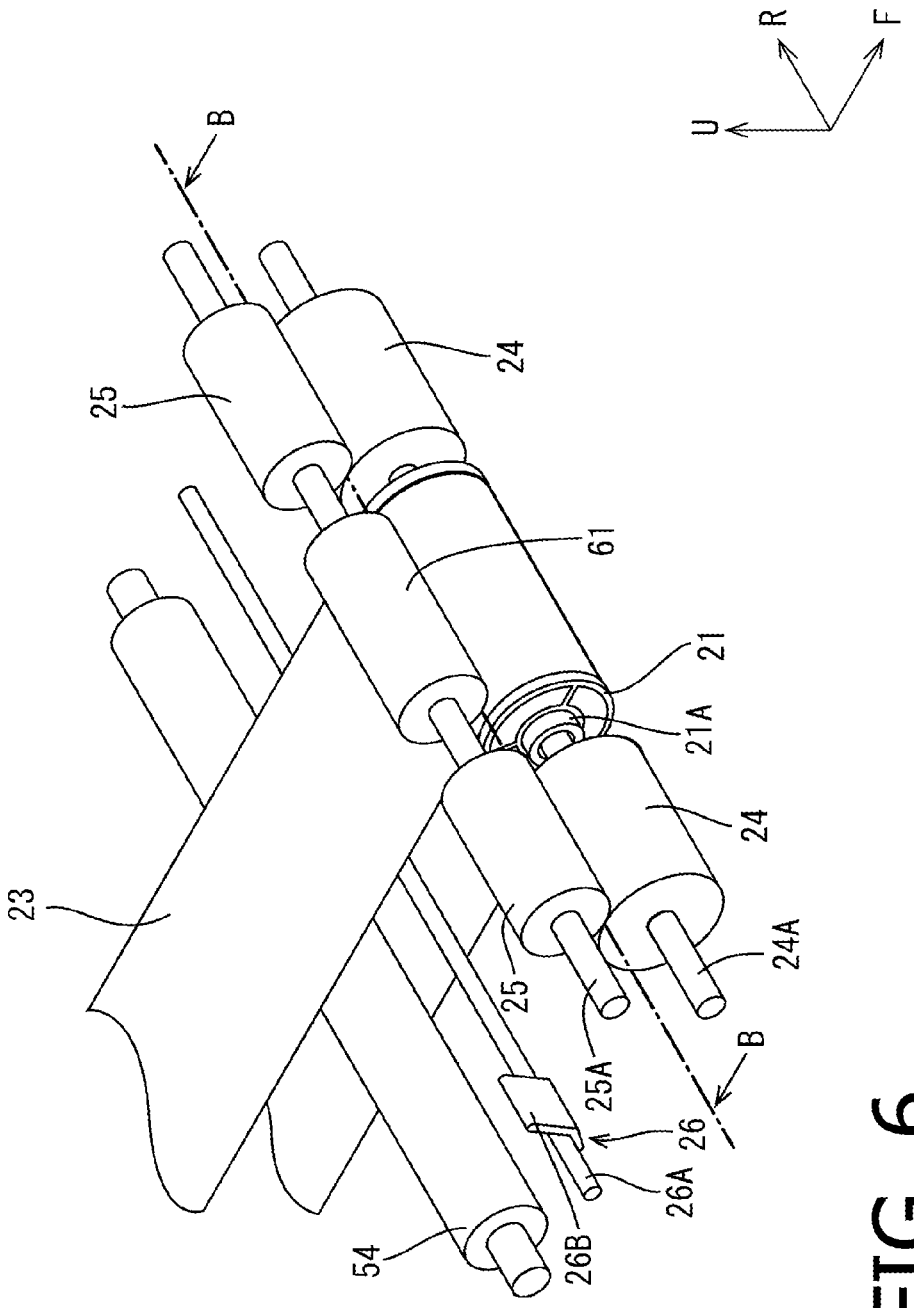


FIG. 6

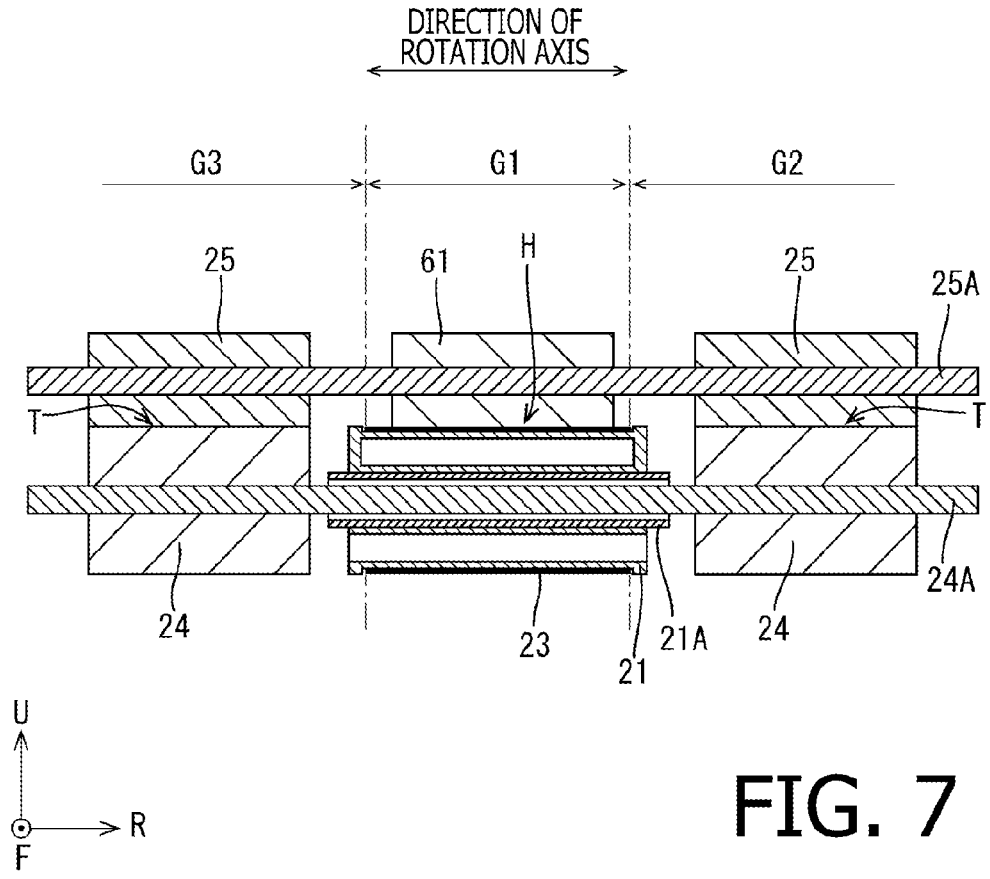

DIRECTION OF
ROTATION AXIS
G3
G1
G2
25
61
H
25
25A
T
T
24
23
21
21A
24
24A
U
R
F

FIG. 7

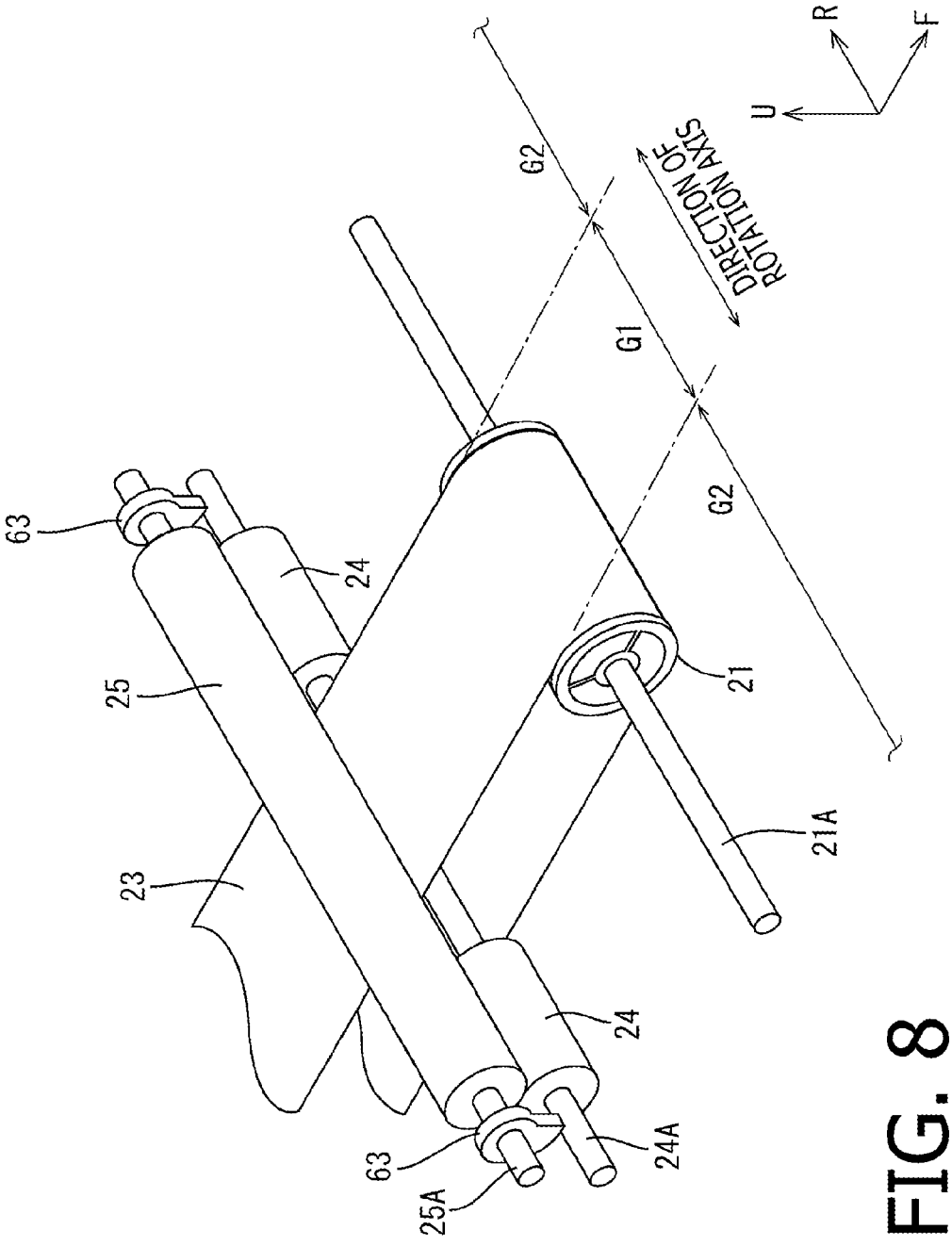
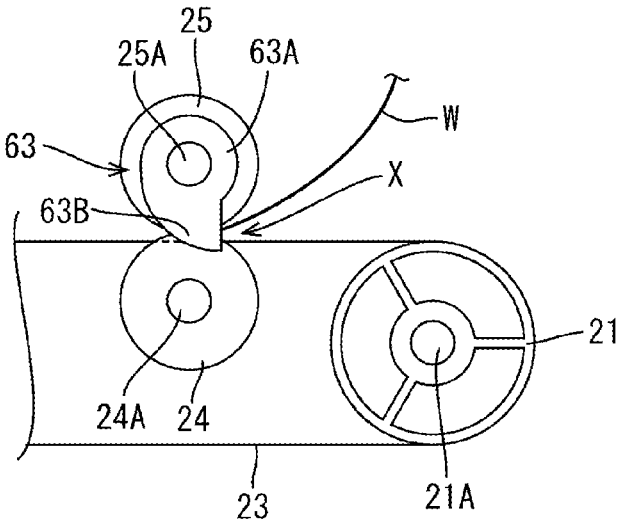

R
F
U
G2
DIRECTION OF ROTATION AXIS
G1
G2
63
24
25
21
21A
23
24
63
24A
25A

FIG. 8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23
21A

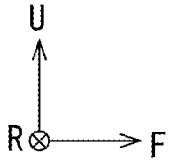
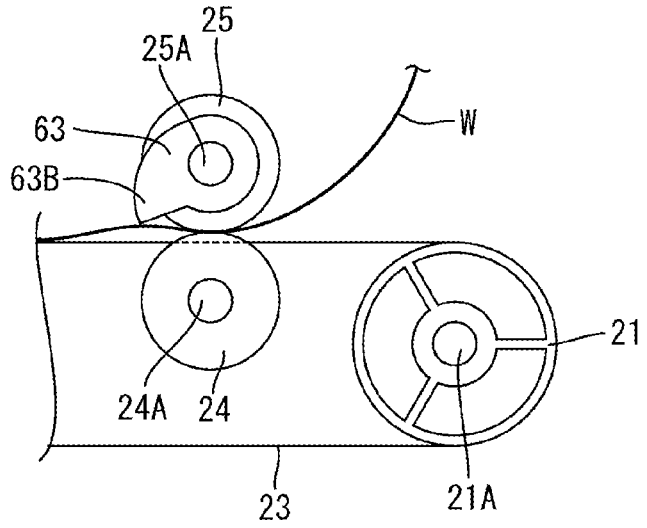

U
R
F

FIG. 9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25A
W
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63B
21
24A
24
23
21A

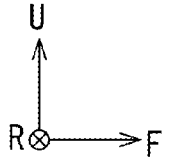
U
R
F

FIG. 10

IMAGE FORMING APPARATUS

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority from Japanese Patent Application No. 2014-017473, filed on Jan. 31, 2014, the entire subject matter of which is incorporated herein by reference.

BACKGROUND

1. Technical Field

An aspect of the present disclosure relates to a technique to correct skew of a sheet by a registration unit and convey the sheet to a belt.

2. Related Art

An image forming apparatus, in which a belt is circulated to convey a sheet, and an image is formed on the sheet being conveyed, is conventionally known. The image forming apparatus may have a registration unit arranged on an upstream side of the belt with regard to a direction of conveying the sheet. The registration unit may have a pair of rollers, of which rotation axes are located outside the belt. The registration unit may correct skew of the sheet to a reference orientation and feed the corrected sheet to the belt.

SUMMARY

In the conventional configuration of the image forming apparatus, the rotation axes of the paired rollers in the registration unit may be located on the outside, e.g., on a side of an outer surface, of the belt. In this regard, a distance for the sheet to travel from the registration unit to the belt may have a considerable length, in which the sheet may be skewed again before reaching the belt. Therefore, even if the skew of the sheet may be corrected to align with the reference orientation by the registration unit, the sheet may be skewed with respect to the reference orientation again while traveling the distance.

The present disclosure is advantageous in that a technique to restrain a sheet from being fed to a belt in a skewed orientation with respect to a reference orientation is provided.

According to an aspect of the present disclosure, an image forming apparatus, including a conveyer, an image forming unit, and a registration unit, is provided. The conveyer includes a first roller, a second roller, and a belt strained around the first roller and the second roller. The belt includes a first surface configured to contact the sheet. The image forming unit is configured to form an image on the sheet being conveyed in an image forming area. The image forming area includes at least a part of a first area and at least a part of a second area. The first area is coincident with the belt, and the second area is displaced from the belt along a direction of rotation axis of the first roller. The registration unit is arranged on an upstream side of the image forming area with regard to a direction of conveyance to convey the sheet by the conveyer. The registration unit includes a third roller and a fourth roller. The third roller is arranged to contact the fourth roller and to locate a rotation axis thereof on a side of the first surface. The fourth roller is arranged in the second area with a rotation axis thereof being located on a side of a second surface of the belt which is a reverse surface of the first surface. The registration unit is configured to manipulate the third roller and the fourth roller to align the sheet with a reference orientation and convey the sheet to the belt.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

FIG. **1** is an illustrative view of a mechanical configuration of a printer according to an exemplary embodiment of the present disclosure.

FIG. **2** is a block diagram to illustrate electrical configuration of the printer according to the exemplary embodiment of the present disclosure.

FIG. **3** is a perspective view of a belt unit of the printer according to the exemplary embodiment of the present disclosure.

FIG. **4** is a top plan view of the belt unit of the printer according to the exemplary embodiment of the present disclosure.

FIG. **5** is a cross-sectional view of the belt unit of the printer, taken along a line A-A shown in FIG. **4**, according to the exemplary embodiment of the present disclosure.

FIG. **6** is an illustrative view of a part of the belt unit of the printer according to the exemplary embodiment of the present disclosure.

FIG. **7** is a cross-sectional view of the belt unit of the printer, taken along a line A-A shown in FIG. **6**, according to the exemplary embodiment of the present disclosure.

FIG. **8** is an illustrative view of a part of the belt unit of the printer according to an exemplary embodiment of the present disclosure.

FIG. **9** is an illustrative side view of a part of the belt unit of the printer according to the exemplary embodiment of the present disclosure.

FIG. **10** is another illustrative side view of the part of the belt unit of the printer according to the exemplary embodiment of the present disclosure.

DETAILED DESCRIPTION

Hereinafter, a printer **1** as an exemplary embodiment of the present disclosure will be described with reference to the accompanying drawings. It is noted that various connections are set forth between elements in the following description. These connections in general, and unless specified otherwise, may be direct or indirect, and this specification is not intended to be limiting in this respect.

The printer **1** is a direct-transferring tandem-typed color laser printer capable of forming images on a sheet in a plurality of (e.g., four) colors, which are, for example, black (K), yellow (Y), magenta (M), and cyan (C). In the following description, directions concerning the printer **1** and each part or component included in the printer **1** will be referred to based on orientations indicated by arrows shown in each drawing. For example, a viewer's right-hand side in FIG. **1** is defined as a front side F, and a left-hand side is defined as rear. A viewer's farther side in FIG. **1** is defined as a right-hand side R of the printer **1**, and a nearer side is defined as a left-hand side. An upper side in FIG. **1** corresponds to an upper side U of the printer **1** according to a direction of gravity. A right-to-left or left-to-right direction of the printer **1** may also be referred to as a right-left direction or a widthwise direction. An up-to-down or down-to-up direction with regard to the direction of gravity may also be referred to as a vertical direction. A front-to-rear or rear-to-front direction may be referred to as a front-rear direction or a direction of depth. Furthermore, directions of the drawings

in FIGS. **3-9** are similarly based on the orientation of the printer **1** as defined above and correspond to those with respect to the printer **1** shown in FIG. **1** even when the printer **1** in the drawings is viewed from different angles. However, the orientations concerning the printer **1** may not necessarily be limited to those described below or indicated in the accompanying drawings. Further, it is noted that a quantity of each of the components and elements denoted by reference signs is, unless otherwise noted, at least one.

In the printer **1** according to the present disclosure, there may be a plurality of parts or components which are in an identical configuration for forming images in the plurality of colors K, Y, M, C. Those identically-configured parts or components may be indicated by the same reference signs except for letters (K, Y, M, C) at the ends thereof, which indicate the different colors. Meanwhile, the reference sigs without the letters (K, Y, M, C) at the ends may be used to represent the plurality of identically-configured parts or components. In the accompanying drawings, reference signs for some of the parts or components in the identical configuration may be omitted.

The printer **1** includes a main casing **2**, a sheet feeder unit **3**, a belt unit **4**, an image forming unit **5**, ejection rollers **6**, and a registration unit **7**.

The sheet feeder unit **3** includes a feeder tray **11**, a pickup roller **12**, feeder rollers **13**, and a sheet guide **14**. The pickup roller **12** forwards sheets W stored in the feeder tray **11** one-by-one to the feeder rollers **13**. The sheet guide **14** is arranged to contact the sheet W being conveyed by the feeder rollers **13** and guide the sheet W to the belt unit **4**.

The belt unit **4** includes a support roller **21**, a driving roller **22**, a belt **23** being an endless belt, and a resilient member **27**, which are supported by a frame **28**. The belt **23** is strained around the support roller **21** and the driving roller **22**. The belt **23** is rolled to circulate in a counterclockwise direction in FIG. **1** to convey the sheet W being contacted with an upper outer surface of the belt **23** toward the rear side.

The resilient member **27** is arranged to urge the support roller **21** in a direction to be away from the driving roller **22**. Thus, the support roller **21** serves to apply tensile force to the belt **23** so that the belt **23** is restricted from loosening between the driving roller **22** and the support roller **21**. On an inner side of the belt **23**, arranged are transfer rollers **54**. The transfer roller **54** includes a transfer roller **54**K for black, a transfer roller **54**Y for yellow, a transfer roller **54**M for magenta, and a transfer roller **54**C for cyan.

The registration unit **7** includes a registration roller **24**, a pinch roller **25**, and a sheet sensor **26**, which are supported by the frame **28** of the belt unit **4**. The registration roller **24** and the pinch roller **25** are arranged to contact the sheet W being conveyed before the sheet W reaches the belt **23** and correct skewing of the sheet W to a reference orientation so that the sheet W is conveyed to the belt **23** in a correct reference orientation in the printer **1**.

The sheet sensor **26** is arranged to detect presence of the sheet W in a detectable area, which is between the registration roller **24** and the transfer rollers **54**, and outputs signals according to detected presence or absence of the sheet W in the detectable area. Based on the signals from the sheet sensor **26**, a timing to form an image on the sheet W is determined.

The image forming unit **5** includes a scanner unit **31**, processing units **32**K, **32**Y, **32**M, **32**C, and a fixing unit **33**.

The scanner unit **31** emits laser beams LK, LY, LM, LC according to image data for the four colors onto surfaces of photosensitive drums **52**K, **52**Y, **52**M, **52**C, which are arranged outside of the belt **23**. Thus, the surfaces of the photosensitive drums **52**K, **52**Y, **52**M, **52**C are selectively exposed to the laser beams LK, LY, LM, LC respectively.

The processing unit **32**K is for forming an image in black and includes a developer roller **51**K, a photosensitive drum **52**K, a charger **53**, and the transfer roller **54**K. The developer roller **51**K, the photosensitive drum **52**K, and the charger **53** are arranged outside of the belt **23**, and the transfer roller **54**K is arranged on the inner side of the belt **23**. The developer roller **51**K supplies a black toner to the photosensitive drum **52**K.

The surface of the photosensitive drum **52**K is electrically charged evenly by the charger **53**, and the charged surface of the photosensitive drum **52**K is selectively exposed to the laser beam LK from the scanner unit **31**. Thus, the exposed area forms an electrostatic latent image. Thereafter, the toner is supplied to the electrostatic latent image by the developer roller **51**K so that a toner image in black is developed on the photosensitive drum **52**K.

The toner image developed on the photosensitive drum **52**K is transferred by static electricity in the transfer roller **54**K onto the sheet W being conveyed on the belt **23**. Thus, the image is formed in the black toner on the sheet W. In the following description, an area, in which the toner image can be transferred to the sheet W, will be referred to as an image forming area GR. The image forming area GR include an image forming area GRK for black, an image forming area GRY for yellow, an image forming area GRM for magenta, and an image forming area GRC for yellow (see FIG. **4**). In this regard, the processing units **32**Y, **32**M, **32**C for yellow, magenta, cyan are in the similar configuration as the processing unit **32**K for black; therefore, description of those are herein omitted.

The fixing unit **33** thermally fixes the toner image transferred onto the sheet W thereat. The sheet W conveyed through the fixing unit **33** is conveyed upward by the ejection rollers **6** and ejected on an ejection tray **2**A, which is arranged at a top of the main casing **2**.

Further to the sheet feeder unit **3**, the belt unit **4** and the image forming unit **5** described above, the printer **1** includes, as shown in FIG. **2**, a central processing unit (CPU) **71**, a read-only memory (ROM) **72**, a random access memory (RAM) **73**, a non-volatile memory **74**, an application specific integrated circuit (ASIC) **75**, a display unit **76**, an operation unit **77**, and a network interface **78**.

The ROM **72** stores a various types of programs including a program to control rotation of rollers such as the driving roller **22** in the belt unit **4** and the registration roller **24**. The RAM **73** and the non-volatile memory **74** provide work areas for the programs when the programs are running and temporary storages for data being used in the programs. The non-volatile memory **74** may be a writable memory device including an NVRAM, a flash memory, an HDD, an EEPROM.

The CPU **71** is connected with various components in the printer **1**, including the ROM **72** and the RAM **73**, and controls the components according to the programs read from the ROM **72**. The display unit **76** includes a liquid crystal display and lamps (not shown) and is capable of displaying information concerning settings, behaviors of the printer **1**, and processes executed in the printer **1**, through various forms of screens. The operation unit **77** includes a plurality of buttons (not shown) and is capable of receiving various types of inputs and instructions from a user. The network interface **78** is an interface, through which communication between the printer **1** and an external device (not shown) is exchanged in wireless or wired communication.

Next, with reference to FIGS. **3-5**, a detailed configuration of the belt unit **4** is described below. The frame **28** of the belt unit **4** supports bearings (unsigned) of the support roller **21**, the driving roller **22**, the registration roller **24**, the pinch roller **25**, and the transfer rollers **54** through a pair of main parts **28**B, which longitudinally extend along a direction of conveyance to convey the sheet W. Thereby, the support roller **21**, the driving roller **22**, the registration roller **24**, the pinch roller **25**, and the transfer rollers **54** are supported in an arrangement such that directions of rotation axes thereof are in parallel with one another. In the following description, the direction in parallel with the rotation axes of the support roller **21**, the driving roller **22**, the registration roller **24**, the pinch roller **25**, and the transfer rollers **54** will be referred to as a direction of rotation axis. The direction of rotation axis coincides with the widthwise direction of the printer **1** according to the exemplary embodiment. The frame **28** further includes intermediate parts **28**C, which connect the paired main parts **28**B with each other along the direction of rotation axis. The intermediate parts **28**C are arranged in positions between the transfer rollers **54**.

A width Wb, which is a dimension of the belt **23** along the direction of rotation axis, is smaller than a width Wt of the transfer rollers **54** along the direction of rotation axis. In this regard, a maximum allowable dimension of the image forming area GR along the direction of rotation axis in each of the processing units **32**K-**32**C is limited by the width Wt of the transfer rollers **54** along the direction of rotation axis. In other words, the width Wb of the belt **23** along the direction of rotation axis is set to be smaller than the dimension of the image forming area GR along the direction of rotation axis.

Therefore, in a plan view from above with regard to the direction of gravity (see FIG. **4**), each transfer roller **54** is in an arrangement with regard to the direction of rotation axis such that a part of the transfer roller **54** is in an overlapping area G**1**, in which the transfer roller **54** coincides with the upper outer surface of the belt **23** along the direction of rotation axis, and a remainder part of the transfer roller **54** is in an exposed area G**2**, in which the transfer roller **54** is displaced from the upper outer surface of the belt **23** along the direction of rotation axis. In this regard, the arrangement that the transfer roller **54** coincides with the belt **23** along the direction of rotation axis refers to a condition that the transfer roller **54** and the belt **23** fall on a same area with regard to the direction of rotation axis. In other words, the transfer roller **54** overlaps the belt **23** in a view along a direction orthogonal to the direction of rotation axis, which is, according to the exemplary embodiment, the direction of gravity. Meanwhile, the arrangement that the transfer roller **54** is displaced from the belt **23** refers to a condition that the transfer roller **54** and the belt **23** do not overlap each other in a view along the direction orthogonal to the direction of rotation axis. The transfer rollers **54**K-**54**C are opposed to the photosensitive drums **52**K-**52**C respectively, across the belt **23** in the overlapping area G**1**, and directly in the exposed area G**2**. In other words, in the overlapping area G**1**, the belt **23** contacts the photosensitive drums **52**K-**52**C, while in the exposed area G**2** the transfer rollers **54**K-**54**C contact the photosensitive drums **52**K-**52**C respectively. Meanwhile, the intermediate parts **28**C coincident with the exposed area G**2** include ribs **28**D, which extend along the direction of conveyance to guide the sheet W.

In the exemplary embodiment, the belt **23** and the transfer rollers **54** are in an arrangement such that a center of the belt **23** along the direction of rotation axis is aligned with centers of the transfer rollers **54** along the direction of rotation axis. Therefore, at each side of the belt **23** along the direction of rotation axis, the exposed area G**2** is provided. In other words, two (2) exposed areas G**2** are arranged on outer sides of the overlapping area G**1** along the direction of rotation axis.

The support roller **21** is formed in a hollow cylindrical shape and has spokes (unsigned) expanding in radial directions at axial ends thereof. The support roller **21** is held via the spokes in a position to be centered at a rotation shaft **21**A. In this regard, the support roller **21** is formed separately from the rotation shaft **21**A and rotates idly with respect to the rotation shaft **21**A.

The driving roller **22** is formed in a hollow cylindrical shape and has spokes (not shown) expanding in radial directions at axial ends thereof. The driving roller **22** is held via the spokes in a position to be centered about a rotation shaft **22**A. In this regard, the driving roller **22** is fixed to the rotation shaft **22** A and rotates integrally with the rotation shaft **22**A.

The driving roller **22** is rotated by a driving force from a motor (not shown), which is activated according to an instruction from the CPU **71**, and applies a circulating force to the belt **23**. The support roller **21** is arranged on an upstream side of the driving roller **22** with regard to the direction of conveyance and is rotated by the circulation of the belt **23**.

While the belt **23** is strained around the support roller **21** and the driving roller **22**, a dimension Ws of the support roller **21** and a dimension Wk of the driving roller **22** along the direction of rotation axis should at least as large as or substantially larger than the width Wb of the belt **23** along the direction of rotation axis. While the width Wb of the belt **23** along the direction of rotation axis is smaller than the width Wt of the transfer rollers **54**, therefore, the dimensions Ws, Wk of the support roller **21** and the driving roller **22** are smaller than the dimension Wt of the transfer rollers **54** along the direction of rotation axis and substantially larger than the width Wb of the belt **23** along the direction of rotation axis.

The support roller **21** is provided with a pair of flange parts **21**B. Each of the flange parts **21**B is formed to spread outwardly with respect to a part of the support roller **21** which contacts the belt **23** along a radial direction. The flange part **21**B is arranged in each exposed area G**2**, which is on an outer side of the belt **23** along the direction of rotation axis. The flange parts **21**B are arranged to face with cross-sectional edges of the belt **23**, which are at widthwise ends along the direction of rotation axis, and restrict the belt **23** from moving in the direction of rotation axis.

Next, the registration roller **24**, the pinch roller **25**, and the sheet sensor **26** will be described. As shown in FIG. **1**, the registration roller **24**, the pinch roller **25**, and the sheet sensor **26** are arranged on a downstream side of the support roller **21** and on an upstream side of the transfer rollers **54**, i.e., an upstream side of the image forming area GR, with regard to the direction of conveyance. The registration roller **24** is made of a material, of which friction coefficient is relatively large, such as rubber, compared to a material of the pinch roller **25**.

The registration roller **24** has a cylindrical form, which is rotatable about a rotation axis **24**A. The registration roller **24** includes two (2) pieces of registration rollers **24**, which align along the direction of rotation axis. Each of the two registration rollers **24** is arranged on each side of the belt **23** along the direction of rotation axis, that is, in each exposed area G**2** located on each side of the overlapping area G**1** with regard to the direction of rotation axis.

As shown in FIG. **5**, the registration roller **24** is arranged to locate the rotation axis **24**A thereof on a side of a reverse surface of the belt **23**, i.e., on an inner side of the belt **23**. At the same time, the registration roller **24** is arranged to locate an upper end thereof to protrude upward from the upper outer surface of the belt **23** in a view taken along the direction of axes.

As shown in FIG. **3**, the pinch roller **25** has a cylindrical form, which is rotatable about a rotation axis **25**A. The pinch roller **25** is arranged to oppose to the registration rollers **24** and in a range along the direction of rotation axis between a leftward end of the registration roller **24** on the left and a rightward end of the registration roller **24** on the right. The pinch roller **25** is a roller coated with fluorine, of which friction coefficient is lower than the registration roller **24**.

As shown in FIG. **5**, the pinch roller **25** is in an arrangement such that the rotation axis **25**A thereof is on the outside of the belt **23**, and a lower end thereof contacts the upper ends of the registration rollers **24**. Therefore, a contact part T, at which the registration roller **24** and the pinch roller **25** contact each other, is in a position upwardly apart from the upper outer surface of the belt **23**.

As shown in FIG. **4**, the sheet sensor **26** is arranged in a position displaced from the belt **23** along the direction of rotation axis. In particular, the sheet sensor **26** is arranged in the exposed area G**2** on the left of the overlapping area G**1** with regard to the direction of axes and in a position closer to the belt **23** than a leftward end of the transfer roller **54** with regard to the direction of axes. The sheet sensor **26** includes an arm **26**B (see FIG. **1**), which is rotatable about a rotation axis **26**A. The sheet sensor **26** is arranged to locate the rotation axis **26**A on the inner side of the belt **23** and to locate an upper end of the arm **26**B to protrude upwardly from the upper outer surface of the belt **23**. When a leading end of the sheet W being conveyed contacts the arm B, the arm **26**B pivots, and the sheet sensor **26** sensing the pivot outputs detection signal, which indicates the leading end of the sheet W reaching a detectable area.

A driving force to drive the registration roller **24** is generated in a motor (not shown) and input to the registration roller **24** through an electromagnetic clutch (not shown). The registration roller **24** is rotated by the electromagnetic clutch when the electromagnetic clutch receives a driving instruction from the CPU **71** and is connected with the registration roller **24**. On the other hand, the registration roller **24** does not rotate or stops rotating when the electromagnetic clutch receives a stopping instruction from the CPU **71** and is disconnected from the registration roller **24**. The pinch roller **25** is rotated along with the rotation of the registration roller **24** and conveys the sheet W to the belt **23** in conjunction with the registration roller **24**.

For example, in advance to the leading end of the sheet W reaching the contact part T between the registration roller **24** and the pinch roller **25**, the CPU **71** outputs the stopping instruction to the electromagnetic clutch to stop the rotation of the registration roller **24** and the pinch roller **25**. Therefore, the sheet W being conveyed by the pickup roller **12** and the feeder rollers **13** is lead to contact the pinch roller **25**, of which friction coefficient is smaller than that of the registration roller **24**, until the leading end of the sheet W reaches the contact part T, and stops thereat.

While the contact part T is formed longitudinally to extend along the direction of rotation axis, an orientation of the sheet W reaching the contact part T is corrected by the contact with the contact part T to a reference orientation, in which the leading end of the sheet W aligns with the direction of rotation axis. After the leading end of the sheet T reaches the contact part T, the CPU **71** outputs the driving instruction to the electromagnetic clutch at a predetermined timing and manipulates the registration roller **24** and the pinch roller **25** to rotate. Thus, the sheet W aligned with the reference orientation is fed to the belt **23** and passed onto the belt **23**.

Meanwhile, the CPU **71** manipulates the driving roller **22** to rotate at a constant velocity to circulate the belt **23** at a constant velocity. In this regard, the belt **23** is continuously rotated regardless of that whether the registration roller **24** and the pinch roller **25** are rotating or halted. The sheet W fed to the belt **23** is conveyed to the rear side by the belt **23** rotating at the constant velocity.

According to the exemplary embodiment described above, the belt unit **4** includes the registration roller **24** and the pinch roller **25**, which convey the sheet W in the reference orientation. The registration roller **24** is disposed in the exposed area G**2**, which is displaced from the belt **23** along the direction of rotation axis, and the rotation axis of the registration roller **24** is on the inner side of the belt **23**. The pinch roller **25** is arranged to locate the rotation axis thereof on the outer side of the belt **23** and to contact the registration roller **24**. According to the above configuration, compared to a configuration, in which the both rotation axes of the registration roller and the pinch roller are located outside the belt **23**, a distance for the sheet W to travel after being corrected to the reference orientation until the sheet W reaches the belt **23** may be shortened. Therefore, the sheet W may be restrained from reaching the belt **23** in a skewed orientation.

According to the exemplary embodiment described above, the registration roller **24** is disposed on each side of the belt **23** along the direction of rotation axis, in each of the exposed areas G**2**. Therefore, compared to a configuration, in which the registration roller is disposed solely in the exposed area G**2** on one side of the belt **23** along the direction of rotation axis, the sheet W may be restrained from being skewed from the reference orientation when the registration roller **24** and the pinch roller **25** convey the sheet W.

According to the exemplary embodiment described above, the contact part T between the registration roller **24** and the pinch roller **25** is located on the upper side of the belt **23** and in the position apart from the upper outer surface of the belt **23**. Therefore, when the orientation of the sheet W is being corrected by the registration roller **24** and the pinch roller **25**, or when the sheet W is conveyed by the registration roller **24** and the pinch roller **23**, an undesirable influence on the orientation of the sheet W, which may otherwise be caused by the sheet W touching the moving belt **23**, may be restrained.

According to the exemplary embodiment described above, the support roller **21**, the driving roller **22**, the registration roller **24**, the pinch roller **25**, and the transfer rollers **54** are supported by the same frame **28**; therefore, these rollers **21**, **22**, **24**, **25**, **54** may be restricted from inclining with respect to one another.

According to the exemplary embodiment described above, while the orientation of the sheet W is corrected by stopping the rotation of the registration roller **24** or maintaining the registration roller **24** motionless, the CPU **71** maintains the circulation of the belt **23**; therefore, the CPU **71** may continuously convey a plurality of sheets W without stopping the circulation of the belt **23** and form images on the sheets W while the registration roller **24** is motionless.

According to the exemplary embodiment described above, the sheet sensor **26** is disposed in the exposed area

G2, which is displaced from the belt **23** along the direction of rotation axis, and in the position closer to the transfer rollers **54** than the registration roller **24** is with regard to the direction of conveyance. Therefore, the timing to convey the orientation-corrected sheet W in the reference orientation to the image forming area GR may be determined by use of the sheet sensor **26** effectively.

According to the exemplary embodiment described above, the rotation axis **26**A of the arm **26**B of the sheet sensor **26** is located on the inner side of the belt **23**. Therefore, compared to a configuration, in which the rotation axis **26**A is located on the outside of the belt **23**, the printer **1** may be downsized.

Next, the printer **1** according to another exemplary embodiment will be described with reference to FIGS. **6-7**. In the exemplary embodiment, the printer **1** is different from the printer **1** described in the previous exemplary embodiment in that the registration rollers **24** are arranged to align with the support roller **21** along the direction of rotation axis, and that an attraction roller **21** is arranged to align with the pinch roller **25** along the direction of rotation axis. In the following description, items or structures which are the same as or similar to the items or the structures described in the previous exemplary embodiment will be referred to by the same reference signs, and description of those will be omitted.

As shown in FIG. **6**, each of the two pieces of registration rollers **24** is arranged on each side of the support roller **21** along the direction of rotation axis. As shown in FIG. **7**, the rotation shaft **21**A of the support roller **21** has a form of a tubular hollow shaft, in which the rotation shaft **24**A of the registration rollers **24** is arranged. Thereby, the registration rollers **24** arranged on the both sides of the support roller **21** along the direction of rotation axis rotate coaxially about the rotation shaft **24**A integrally with each other.

The rotation shaft **21**A of the support roller **21** is arranged separately from the rotation shaft **24**A of the registration rollers **24**; therefore, the support roller **21** rotates independently from the rotation of the registration rollers **24**. An inner diameter of the rotation shaft **21**A is larger than an outer diameter of the rotation shaft **24**A. Therefore, even when the support roller **21** is urged by the resilient member **27** in the direction to be away from the driving roller **22**, the rotation shaft **24**A may be restrained from contacting the rotation shaft **21**A.

The pinch roller **25** includes two (2) pieces of pinch rollers **25**, which are arranged to align along the direction of rotation axis. Each pinch roller **25** is arranged to face and contact one of the two registration rollers **24**. Thus, each of the pinch rollers **25** is arranged on each side of the belt **23** along the direction of rotation axis and in each of the exposed areas G**2**, which are on the both sides of the overlapping area G**1** along the direction of rotation axis.

The attraction roller **61** is arranged in a position between the two pinch rollers **25** along the direction of axes. The attraction roller **61** electrically charges the sheet W being conveyed to the belt **23** so that the sheet W should be attracted to the belt **23**. The attraction roller **61** is in a cylindrical form and shares the rotation shaft **25**A with the pinch rollers **25**.

The attraction roller **61** is arranged in a position to coincide with the outer upper surface of the belt **23** with regard to the direction of rotation axis. In other words, the attraction roller **61** is arranged in the overlapping area G**1**, and a lower end of the attraction roller **61** is located to contact the belt **23**. A contact part H between the attraction roller **61** and the belt **23** is arranged to align substantially with a same line along the direction of rotation axis as the contact parts T between the registration rollers **24** and the pinch rollers **25**. In this regard, the attraction roller **61** is arranged to oppose to the support roller **21** across the belt **23**.

According to the exemplary embodiment described above, the support roller **21** and the registration rollers **24** are arranged to align along the direction of rotation axis. Therefore, compared to a configuration, in which the support roller **21** and the registration rollers **24** do not align with one another along the direction of rotation axis, the printer **1** may be downsized.

According to the exemplary embodiment described above, the registration rollers **24** arranged on the both sides of the belt **23** along the direction of rotation axis rotate integrally with each other through the rotation shaft **24**A which is arranged inside the hollow rotation shaft **21**A of the support roller **21**. Therefore, compared to a configuration, in which the registration rollers **24** rotate independently from each other, the sheet W may be restrained from skewing with respect to the reference orientation.

Next, the printer **1** according to still another exemplary embodiment will be described with reference to FIGS. **8-10**. In the exemplary embodiment, the printer **1** is different from the printer **1** described in the previous exemplary embodiments in that the printer **1** includes a registration member **63** arranged on a rotation shaft of the pinch roller **25**. In the following description, items or structures which are the same as or similar to the items or the structures described in the previous exemplary embodiment will be referred to by the same reference signs, and description of those will be omitted.

As shown in FIG. **8**, the registration member **63** includes two (2) pieces of registration members **63**, which are arranged along the direction of rotation axis and are rotatable about the rotation shaft **25**A of the pinch roller **25**. The registration members **63** are arranged on outside of the belt **23** and in outer positions than the pinch roller **25** with regard to the direction of rotation axis, in the exposed areas G**2** which are on the outer sides of the overlapping area G**1**. As shown in FIG. **9**, each registration member **63** is formed to have a projection **63**B, which projects outward in a radial direction from a cylindrical main part **63**A, and is placed to halt in a posture, in which the projection **63**B is in a lower position. In the following description, the lower position of the projection **63**B shown in FIG. **9** will be defined as a contact position.

When the projection **63**B is in the contact position, a face of the projection **63**B on the upstream side with regard to the direction of conveyance is on an upstream side of the contact part T between the registration roller **24** and the pinch roller **25**. In the following description, the face of the projection **63**B on the upstream side with regard to the direction of conveyance is defined as a contact face X. With the projection **63**B in the contact position, therefore, the sheet W conveyed by the feeder roller **12** and the feeder rollers **13** contacts the contact face X prior to reaching the contact part T.

When the leading end of the sheet W being conveyed contacts the contact face X, a rotating force is applied from the sheet W to the registration member **63**, and the registration member **63** rotates about the rotation shaft **25**A of the pinch roller **25** along the conveyance of the sheet W toward the downstream with regard to the direction of conveyance. The contact face X spreads along the direction of rotation axis; therefore, when the sheet W contacts the contact face X, the leading edge of the sheet W aligns with the direction of rotation axis by rotation resistance of the registration

member **63**, and the orientation of the sheet W is corrected to the reference orientation. The rotation resistance may be caused in the registration member **63** by, for example, own weight of the registration member **63** or by a spring (not shown).

When the sheet W is conveyed to the belt **23**, the CPU **71** manipulates the registration roller **24** to rotate at a constant velocity. Therefore, when the leading end of the sheet W in the corrected reference orientation reaches the contact part T between the registration roller **24** and the pinch roller **25**, the sheet W is conveyed by the registration roller **24** and the pinch roller **25** in the direction of conveyance.

Thereafter, as shown in FIG. **10**, when the projection **63**B comes to an upper position higher than the sheet W being conveyed, the registration members **63** stop rotating thereat while the sheet W passes underneath the registration members **63** to be conveyed to the belt **23**. In the following description, the upper position of the projection **63**B higher than the sheet W being conveyed is defined as a conveyable position. The projection **63**B is maintained stopped at the conveyable position throughout a period during the sheet W passes through the registration members **63**. When the sheet W is conveyed through, the registration members **63** are rotated to return to the contact position on the upstream side of the contact part T with regard to the direction of conveyance.

According to the exemplary embodiment described above, while the orientation of the sheet W is corrected by the registration members **63**, the CPU **71** maintains the registration roller **24** rotating. Therefore, the rotation of the registration roller **24** may not necessarily be stopped while the orientation of the sheet W is corrected, and control over the registration roller **24** by the CPU **71** may be simplified.

Although examples of carrying out the disclosure have been described, those skilled in the art will appreciate that there are numerous variations and permutations of the image forming apparatus that fall within the spirit and scope of the disclosure as set forth in the appended claims. It is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or act described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

For example, the image forming apparatus may not necessarily be limited to the multicolor laser printer but may be a printer for forming images in a different image-forming method, such as an inkjet printer with the belt conveyer. In the inkjet printer, for example, an ink ejecting area for an inkjet head may equivalently serve as the image forming area GR. For another example, the image forming apparatus may not necessarily be a multicolor printer but may be a monochrome printer.

For another example, the support roller **21** and the driving roller **22** may not necessarily be the only rollers to strain the belt **23** around, but an additional roller to strain the belt **23** around may be provided in addition to the support roller **21** and the driving roller **22**.

For another example, rotation of the rollers including the driving roller **22** the registration roller **24** may not necessarily be controlled by the single CPU **71** but may be controlled by a plurality of CPUs, or may be controlled by a dedicated hardware circuit such as the ASIC **75** or by the CPU(s) and hardware circuits.

For another example, the sheet sensor **26** may not necessarily detect the presence of the sheet W by the mechanical contact of the sheet W with the arm **26**B but may detect the sheet W optically by emitting light toward the sheet W and receiving light reflected on the sheet W.

For another example, the registration roller **24** may not necessarily be arranged to have the rotation axis **24**A thereof to extend continuously through the inner side of the belt **23** along the direction of rotation axis as long as the rotation axis **24**A of the registration roller **24** is located on the inner side of the belt **23** when the belt unit **4** is viewed along the direction of rotation axis. Further, the pinch roller **25** may not necessarily be arranged to have the rotation axis **25**A thereof to extend continuously through the outer side of the belt **23** along the direction of rotation axis as long as the rotation axis **25**A of the pinch roller **25** is located on the outer side of the belt **23** when the belt unit **4** is viewed along the direction of rotation axis.

For another example, the belt **23** may not necessarily be arranged to locate the center thereof along the direction of rotation axis to align with the center of the transfer roller **54** along the direction of rotation axis. For example, the belt **23** may be arranged to locate a leftward end thereof to align with a leftward end of the transfer roller **54**. For another example, the belt **23** may not necessarily be a single piece of belt **23** but may include a plurality of pieces of belts **23**.

For another example, the width Wb of the belt **23** along the direction of rotation axis may not necessarily be smaller than the dimension Wt of the transfer rollers **54** but may be substantially the same dimension as the dimension Wt of the transfer rollers **54**. If the width Wb of the belt **23** along the direction of rotation axis is substantially as wide as the dimension Wt of the transfer rollers **54**, it may be necessary that a width of the sheet W along the direction of rotation axis is larger than the dimension Wt of the transfer rollers **54** along the direction of rotation axis, and the registration rollers **24** may be disposed in areas where the sheet W spreads beyond the transfer rollers **54** along the direction of rotation axis so that the orientation of the sheet W is corrected by the registration rollers **24** disposed in the spread-beyond areas.

For another example, the registration roller **24** may not necessarily include two (2) pieces of registration rollers **24** arranged to align along the direction of rotation axis. If a single piece of registration roller **24** is formed to have a larger dimension along the direction of rotation axis so that the orientation of the sheet W may be corrected by the single piece of registration roller **24**, a quantity of the registration roller **24** may be one (1). Similarly, a quantity of the registration members **63** may not necessarily be limited to two (2) but may be one (1).

For another example, the support roller **21** may not necessarily serve to apply the tensile force to the belt **23**. In other words, the support roller **21** may not necessarily be movable with respect to the registration roller **24** along the direction orthogonal to the direction of rotation axis. If so, the rotation axis **24**A of the registration roller **24**, which is on the inner side of the rotation shaft **21**A of the support roller **21**, may be located coaxially on the rotation shaft **21**A of the support roller **21**. Thereby, when the support roller **21** and the registration roller **24** are installed in the belt unit **4**, a position of one of the support roller **21** and the registration roller **24** may be determined based on a position of the other of the support roller **21** and the registration roller **24**.

What is claimed is:

1. An image forming apparatus, comprising:

a conveyer configured to convey a sheet, comprising:

a first roller;

a second roller; and

a belt strained around the first roller and the second roller and comprising a first surface and a second surface,

the first surface facing one side to contact the sheet, and

the second surface facing an opposite side from the first surface;

an image forming unit configured to form an image on the sheet being conveyed in an image forming area,

the image forming area comprising at least a part of a first area and at least a part of a second area,

the first area being coincident with the first surface of the belt, and

the second area being in a same position as the first surface of the belt in a direction of conveyance to convey the sheet by the conveyer, the second area being displaced from the belt along a direction of rotation axis of the first roller; and

a registration unit arranged on an upstream side of the image forming area with regard to the direction of conveyance,

the registration unit comprising a third roller and a fourth roller,

the third roller being arranged to contact the fourth roller and to locate a rotation axis thereof on a side of the first surface,

the fourth roller being arranged in the second area with a rotation axis thereof being located on a side of the second surface of the belt, and

the registration unit being configured to manipulate the third roller and the fourth roller to align the sheet with a reference orientation and convey the sheet to the belt.

2. The image forming apparatus according to claim **1**,

wherein the second area is provided on each side of the belt along the direction of rotation axis; and

wherein the registration unit comprises the fourth roller, which is arranged in the second area on each side of the belt along the direction of rotation axis.

3. The image forming apparatus according to claim **1**,

wherein a contact part between the third roller and the fourth roller is located on the side of the first surface in a position apart from the first surface.

4. The image forming apparatus according to claim **1**,

wherein the first roller is arranged on an upstream side and the second roller is arranged on a downstream side with regard to the direction of conveyance, and

wherein the fourth roller is arranged to align with the first roller along the direction of rotation axis.

5. The image forming apparatus according to claim **4**,

wherein the first roller comprises a hollow shaft;

wherein the second area is provided on each side of the belt along the direction of rotation axis; and

wherein the registration unit comprises the fourth roller, which is arranged in the second area on each side of the belt; and

wherein a rotation shaft, through which the fourth roller is rotated integrally, is arranged inside the hollow shaft.

6. The image forming apparatus according to claim **5**,

wherein a rotation axis of the first roller and the rotation shaft of the fourth roller are arranged coaxially.

7. The image forming apparatus according to claim **1**, further comprising:

a frame configured to support the first roller, the second roller, and the fourth roller.

8. The image forming apparatus according to claim **1**, further comprising:

a feeder roller configured to convey the sheet toward the registration unit; and

a controller configured to control the registration unit and the feeder roller,

wherein the controller controls the feeder roller to convey the sheet and controls the third roller and fourth roller to stop rotating until a leading end of the sheet being conveyed contacts the third roller and the fourth roller, and thereafter controls the third roller and the fourth roller to start rotating and convey the sheet aligned with the reference orientation to the belt.

9. The image forming apparatus according to claim **8**,

wherein the controller comprises a conveyer controller configured to control the conveyer, and

wherein the conveyer controller controls the belt to circulate while rotation of the third roller and the fourth roller is stopped.

10. The image forming apparatus according to claim **1**,

wherein the registration unit comprises a contact portion configured to be rotated about a rotation axis, the contact portion being rotatable from a contact position to a conveyable position, the contact position being on an upstream side of a contact part between the third roller and the fourth roller with regard to the direction of conveyance, and the conveyable position being on a downstream side of the contact position with regard to the direction of conveyance.

11. The image forming apparatus according to claim **1**, further comprising:

a detector arranged in a position between the fourth roller and the image forming area with regard to the direction of conveyance, the detector being configured to detect presence of the sheet, the detector comprising an arm arranged in the second area.

12. The image forming apparatus according to claim **11**,

wherein the arm of the detector is rotatable by a contact with the sheet; and

wherein a rotation axis of the arm is located on the side of the second surface.

13. The image forming apparatus according to claim **1**,

wherein the image forming unit comprises:

a photosensitive member arranged on the side of the first surface, the photosensitive member being configured to carry an image formed in a developer agent; and

a transfer member arranged on the side of the second surface, the transfer member being configured to transfer the image formed in the developer agent to the sheet in the image forming area.

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